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16. ABSTRACT

Because early models of belt filter presses (developed from technology associated with the manufacture of paper) performed poorly, improved design and operation procedures for these presses were studied. Belt filter presses form part of a sludge dewatering system, and in terms of integration within the overall treatment process, their performance varies directly with the solids concentration of the feed sludge. Overal performance can be improved if fluctuations in the quality and character of the feed sludge are minimized.

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INTRODUCTION

This paper summarizes the findings of a study performed under contract with the U.S. Environmental Protection Agency. The intent of the study was to identify and concisely document improved design and operation procedures for belt filter presses that have been developed from field experience. The study included extensive telephone discussions with belt press operators, visits to nine operating belt filter press installations, contacts with belt press manufacturers, and an extensive literature review.

This paper discusses application of the belt press, as well as selection and application of ancillary equipment associated with the belt filter press.

Belt filter presses were developed from technology associated with the manufacture of paper, and have had a number of problems in being transferred to municipal sludge applications. Early models demonstrated poor performance and durability. Most of these early development problems have been eliminated. Although durability can still be a problem, this is becoming less frequent as engineers tighten up their specifications to require higher quality equipment.

EQUIPMENT DESCRIPTION

Belt filter presses are sludge dewatering devices which use the principles of chemical flocculation, gravity drainage and mechanically-applied pressure to continuously dewater sludge. A simplified schematic of this device is presented in Figure 1.

In most belt presses, conditioned sludge is introduced on a gravity drainage section where it is allowed to thicken. This allows a majority of the free water to drain from the sludge. On some devices this section is provided with a vacuum assist which enhances

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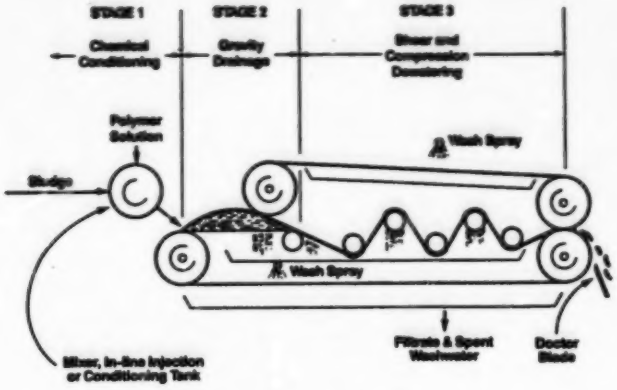
FIGURE 1 THE THREE BASIC STAGES OF A BELT FILTER PRESS



drainage, and may help to reduce odors. Following gravity drainage, pressure is applied, first in a low pressure section, then in a high pressure section.

In the pressure stage, the sludge is subjected to pressure by being squeezed between opposing cloth belts. The belts are held in place by a series of rollers. In most presses, the sludge is also subjected to shearing forces as the belts pass through a series of off-set rollers that define a serpentine path for the belts. The squeezing and shearing forces thus introduced release additional quantities of water from the sludge.

Belt filter presses may be utilized to dewater nearly all types of sludges generated at municipal wastewater treatment plants. The major exceptions are sludges that are primarily chemical in nature, and sludges that have been conditioned or stabilized with lime. Typical performance data for belt filter presses on various types of sludge are provided in the literature (2). In most cases, the sludge cake produced on belt presses has sufficiently high solids content to allow all types of disposal methods, including direct incineration. Because it is polymer conditioned, belt press cake has a higher volatile solids proportion than other sludge cakes, making it more amenable to incineration or composting.

An interrelated system of auxiliary components supports the operation of the belt filter press. This ancillary equipment includes sludge feed pumps; polymer mixing and feeding systems; high pressure (60 psi and greater) belt washwater systems; and sludge cake conveying systems.

DESIGN CONSIDERATIONS

There are approximately 20 manufacturers of belt filter presses. Each manufacturer produces a press having slightly different quality, mechanical features and operating characteristics. Belt filter presses are available in size ranges

from approximately 0.5 meters to 3.5 meters in width. Widths of 1.5 to 2.5 meters currently appear to be the most practical.

The major components of the belt filter press are its frame; belts; rollers and bearings; belt tracking and tensioning systems; and its controls and drives. Other components include a flocculation system; and cake discharge blades and monitoring devices.

Various types and shapes of materials can be used in frame construction. Generally, structural steel that has been coated to resist corrosion is utilized. Welded frames are normally more durable than bolted frames.

Belts are woven synthetic fibers, generally rayon, nylon or polyester. Various material and weave combinations are available from belt suppliers. Either seamed, interlocked closure, or seamless type belts are available. As discussed herein, interlocked closure type belts are those provided with interwoven closures that provide a smooth transition where belts are joined.

Rollers and bearings are the mechanical heart of the belt filter press. Rollers provide the pressure and shear in the compression zone of the press, as well as assuring proper belt support and tension. They are available in a variety of materials, including stainless steel and rubber coated. Perforated rollers (normally stainless steel) are used in initial pressure stages by some manufacturers to enhance drainage. The rollers are supported on and guided through bearings, normally the pillow-block type.

Belt tracking and tensioning systems utilize electro-mechanical sensors to determine the position and force applied to the press belts. They act through the press instrumentation system to hydraulically, pneumatically or electronically realign and adjust belt position and tension. Both continuously acting and on-off devices are available.

Belt press controls include the instrumentation necessary to maintain press operation. They are provided in accordance with the needs of each facility and as a minimum contain starting and stopping devices for the press and its auxiliaries; the instrumentation for the belt tensioning and tracking system; and any required safety interlocks. The main belt press drive is an electric motor, as are the drives for auxiliaries such as the flocculation system and the belt washing system.

Most belt presses come equipped with an integral sludge conditioning system. However, this system can be varied by the user, and separate flocculation devices can be specified. The devices are normally a flocculation tank mixing drum, or an in-line chemical mixer such as a static-tube.

Cake discharge is accomplished over a discharge roller and assisted by a discharge, or doctor blade. The position and pressure

of the doctor blade against the belt press discharge roller are adjustable.

PROBLEM AREAS AND POTENTIAL SOLUTIONS

The major problems encountered with use of belt filter presses are related to (a) equipment quality; (b) operating practices; (c) integration of ancillary systems; (d) process integration.

Equipment Quality

The problems associated with equipment quality primarily involve belt quality; the ease of adjustment and reliability of tension and tracking systems; and roller and bearing quality. It must be noted that many of these problems are associated with the initial installations at which belt presses were installed and that the better manufacturers of this equipment have eliminated many of these problems. Other equipment problems include frame and instrument corrosion; inadequate safety arrangements; and poor noise control.

Belt Tear. Torn belts are one of the major problems associated with use of belt presses. The causes for belt tearing include inferior quality belt material, misalignment of the equipment and improper operation and maintenance. The major causes for belt tear and associated remedial measures are shown in Table 1. Many of these problem areas have been reduced or eliminated by improvements in belt press design and/or improved materials for the belts themselves.

Belt Tensioning/Tracking. Low quality belt tensioning/tracking systems are generally associated with poorer quality belt filter presses. Systems that utilize exposed gearing present a safety hazard, those which are not continuously acting will impose a jarring action on belts. Retrofit of improved tensioning/tracking systems on existing equipment should be considered, but is generally difficult and costly. In new facilities, specifications should require easily maintained, continuously acting systems with properly housed gearing.

Roller Failure. Roller failure can be caused by faulty equipment, or by passage of large material such as heavy rags on to the press. High quality, corrosion resistant rollers should be utilized. If problems with foreign objects are being experienced, the sludge should be ground or screened prior to dewatering. In new installations, sludge grinders should be provided prior to dewatering.

Bearing Failures. The causes and remedial measures for a high frequency of bearing failures are presented in Table 2. In general, durable bearings with an L-10 life of 100,000 hours or more should be specified.

TABLE 1. CAUSES AND REMEDIAL MEASURES FOR BELT TEAR

Causes	Remedial Measures
1. Inferior quality belt material	1. Use of high quality belts a. Replace existing belts b. Specify high quality, require a two-year warranty.
2. Wear at seam on seamed belts	2. Use of interlocking or unseamed belts a. Replace existing belts b. Specify interlocking or unseamed belts.
3. Failure of belt in high pressure zone due to tensioning and tracking problems a. Formation of creases in belt are evidence of problem	3. Presses that utilize improved tensioning and tracking systems have fewer problems. a. Replacement of tension/tracking systems b. Specify high quality tensioning/tracking systems
4. Misalignment of rollers	4. Roller alignment should be checked and adjusted as necessary.
5. Belt shifting and/or creasing due to: a. Uneven feed distribution b. insufficient washdown	5. Check sludge distribution and review washdown procedures, then: a. Improve sludge distribution to gravity drainage zone of press if possible. b. Require improved washdown and press maintenance.
6. High wear due to use of hard plastic doctor blade	6. Replace blade with a more resilient ultra-high molecular weight plate.

Press Drainage. Poor drainage of belt presses presents housekeeping, safety, and morale problems. Improved press drainage pan designs, and increased attention to design of press support wells are solutions.

Gravity Sludge Drainage. Where insufficient gravity drainage is achieved, dewatering performance is diminished. Poor drainage can be a result of an insufficient gravity drainage section, or of poor spreading of sludge on the gravity drainage section. Sludge

TABLE 2. CAUSES AND REMEDIAL MEASURES FOR BEARING FAILURES

Causes	Remedial Measures
1. Improper alignment of rollers due to: a. Poor alignment during assembly or maintenance. b. Structural frame problems	1. Properly align rollers by: a. Proper installation and maintenance b. Use of durable frames c. Stiffening of frame and realignment of rollers.
2. Poor bearing protection and/or improper seals	2. Utilize double or triple sealed bearings.
3. Poor bearings lubrication due to: a. Poor maintenance practices b. Poor bearing location and/or poor location of grease fittings	3. Improve lubrication practices by: a. Requiring ease of lubrication on new equipment b. Requiring proper maintenance c. Relocate grease fittings and/or extend them for ease of maintenance on existing equipment.

spreading is improved by provision of furrow devices at the head end of gravity drainage sections. Drainage can be improved operationally by reducing press speed.

Belt Cleaning. Belt cleaning problems result from improperly sized washwater systems and/or to clogging of spray nozzels. Washwater pumps should have sufficient pressure and flow to meet manufacturers requirements. Washwater needs should be verified and certified by suppliers. Washwater pumps should be furnished by the same supplier as the belt press. Spray nozzles and washwater piping system should be designed for ease of cleaning. Some manufacturers provide stainless steel cleaning brushes within spray header systems to facilitate cleaning. Where plant effluent is used for washwater, strainers should be installed in the system and provision for final washdown and flushing with potable water should be considered.

Personal Safety. Personnel safety needs must be fully considered. Adequate safety stops and trip wires around machinery; proper equipment access; non-slip walkways and floors; and sufficient lighting must be provided and properly maintained. Sound deadening material should be used in the walls and ceilings of dewatering rooms to reduce noise levels.

Operational Concerns

Few of the difficulties related to belt filter press dewatering are associated with operation of the units. Those

operational problems that are encountered can generally be corrected by provision of improved levels of training, either initially or as follow up during the first few years of plant operation.

Process Application

The sludge handling system in which dewatering equipment is employed can have a significant impact on its performance. In some cases, belt filter press performance has been substantially affected by the processes and operations preceding it, in others belt presses were misapplied.

High pressure/tension presses are more complex and require more maintenance than lower pressure machines. When the high cake solids produced on the latter devices are not a requirement, the added maintenance is not worthwhile.

Wide variations in sludge characteristics can result in poor conditioning and in reduced dewatering efficiency. Sludge blending facilities are needed where sludge characteristics are likely to vary widely.

Auxiliary Systems

A number of problems associated with belt filter press dewatering are a result of poor selection, location, or design of the auxiliary equipment associated with the operation. Major problems with this ancillary equipment include (a) the selection and location of controls; (b) polymer system problems; (c) problems with selection and design of outfeed conveyors; and (d) inadequate provisions for maintenance.

Controls. Problems related to selection and location of controls include poor positioning of controls, a lack of centralized controls, and inadequate control interlocks.

Additionally, controls are often not constructed of materials suitable for the moist, corrosive atmosphere found in dewatering rooms, or are not adequately protected from this environment.

The controls for the belt press and its auxiliary equipment should be centralized. This should include controls for the press, polymer feed system, sludge feed system and sludge cake conveyance system, as a minimum. The controls should be located in a separate room or be enclosed behind a vision panel to protect them from moisture. To avoid corrosion problems, air used in pneumatic controls should be dried. Where controls are located in a control room, the room should have a separate air handling system and be located for ease of observation. Where possible, controls should be located to allow ease of observation of the gravity drainage section the press.

The controls for the sludge dewatering system should be interlocked to assure coordinated operation. Sludge feed, polymer

feed, and belt press startup and shut down should be properly staged for either automatic or manual operation.

Polymer Feed System. Difficulties encountered with polymer feed systems include polymer processing unit malfunctions, improperly sized feed equipment, inadequate mixing of polymer and sludge, and an inability to pace polymer feed rate with sludge flow. Specifications should require proven performance from processing units and polymer feed equipment should be sized to handle the broadest range of both liquid and dry polymers and dosage rates possible.

Equipment Access. Access to the belt press and its auxiliaries is sometimes inadequate. This is often the case where equipment is retrofitted. Adequate platforms and/or walkways should be provided around presses and space should be allowed on one side of each press for roller removal. Facilities for lifting or hoisting heavy equipment should also be provided.

Sludge Feed. Sludge feed problems include uneven sludge feed associated with use of reciprocating pumps and high maintenance associated with use of progressive cavity pumps. Use of reciprocating pumps is generally not recommended by belt press manufacturers and should be avoided. Progressive cavity pump problems can be reduced by removal of grit and rags prior to pumping. Grinding of rags is also recommended as it will serve to reduce the potential for roller problems. Where service conditions permit, rotary lobe pumps can provide adequate continuous sludge feed.

Odor Control. Where septic sludge, or sludge containing highly odorous material is dewatered, odor release within dewatering rooms can pose a significant problem. Dewatering rooms should be adequately ventilated with at least six air changes per hour. Overhead exhaust systems are helpful in eliminating gases.

SUMMARY

Designers and operators should keep in mind that belt filter presses form part of a sludge dewatering system. In terms of integration within the overall treatment process, belt filter performance varies directly with feed sludge solids' concentration. It has been found that the overall performance of the belt press can be improved if fluctuations in the quality and character of the feed sludge are minimized.

In selecting a belt filter press, the design engineer should consult equipment suppliers for estimated performance data and other design requirements, then carefully review and confirm all claims. Specifications should contain requirements for durable equipment; should call for performance bonds; and should require that key auxiliaries such as the belt wash system be the responsibility of a single supplier.

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